Low carbon scenarios in 2050, korea

-- An Application of Energy Snapshot Tool --

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NIES, Tsukuba, Japan

Chan PARK, Seoul National University
Sun Yong SUNG, Seoul National University

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Background

- T/F team will establish the 4th total countermeasures of climate change(’08~’12) to quantify total GHG reduction target and make sectoral roadmap for Low Carbon Society
- Korea government are discussing the Low Carbon Society scenarios and vision now to reduce GHG emissions
- GHG reduction will be achieved by improvement of technology level and change of social structure in 2050 year

LCS Scenarios Summary

	2005	Scenario A	Scenario B
GDP (annual)	4.20%	3.36%	2.98%
Population(‘000)	48,183	42,343	43,623
Household(‘000)	15,971	18,330	18,252
Average family members	2.89	2.21	2.39
Urbanization rate	80.8	93%	88%
Market	- Regulations	- Deregulation	- Adequate rules and regulations
Life style	- Convenient lifestyle	- More convenient lifestyle	- Reducing the attraction towards apartment complex

Socio-Economic Projections

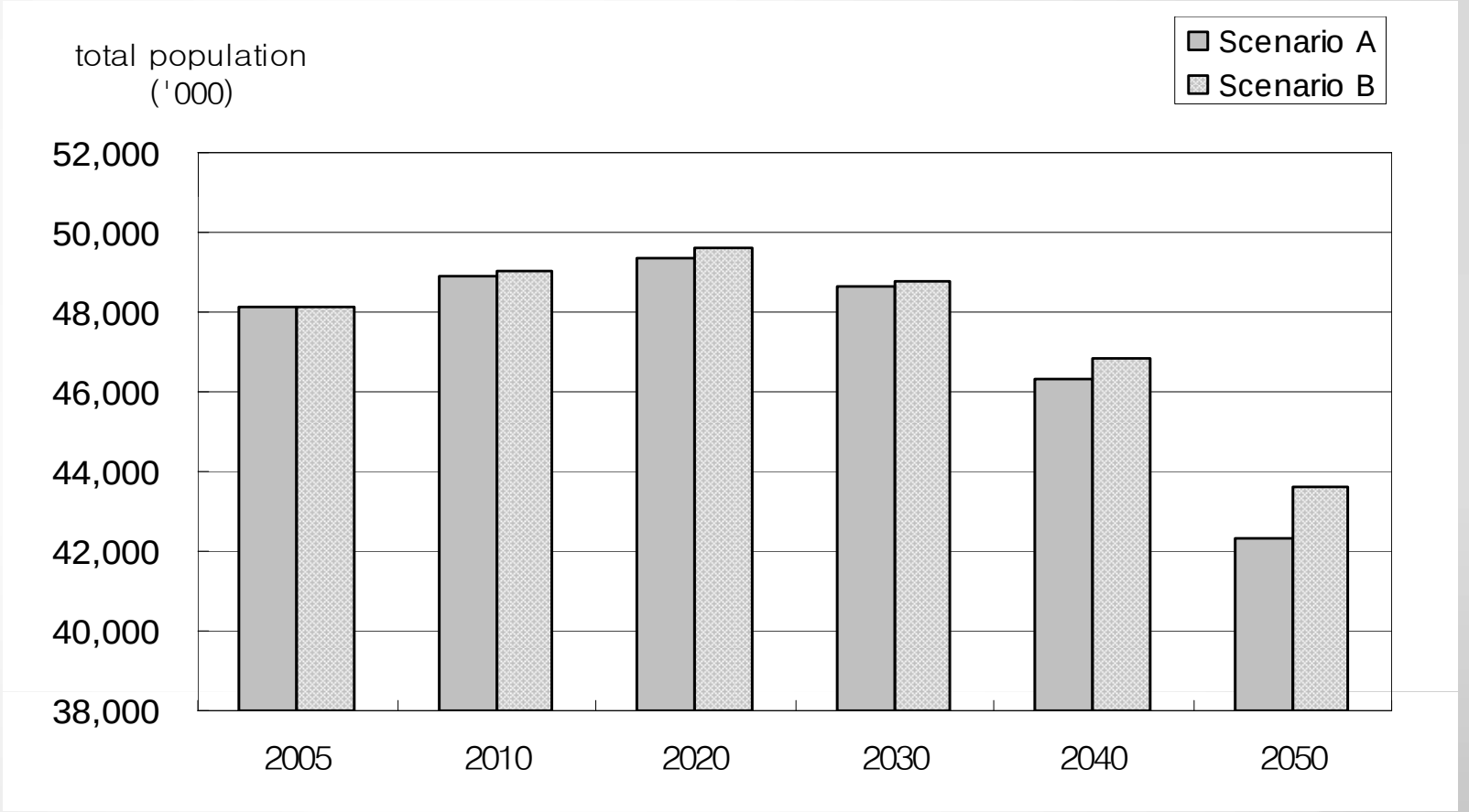
- GDP
- Population and household
- Industrial structure

GDP growth

Year	Scenario A	Scenario B
2000-2004	5.42	5.42
2005	4.20	4.20
2006-2010	4.67	4.07
2011-2020	4.12	3.62
2021-2030	3.48	3.08
2031-2040	2.68	2.38
2041-2050	2.51	2.31
2005~2050 average	3.36	2.98

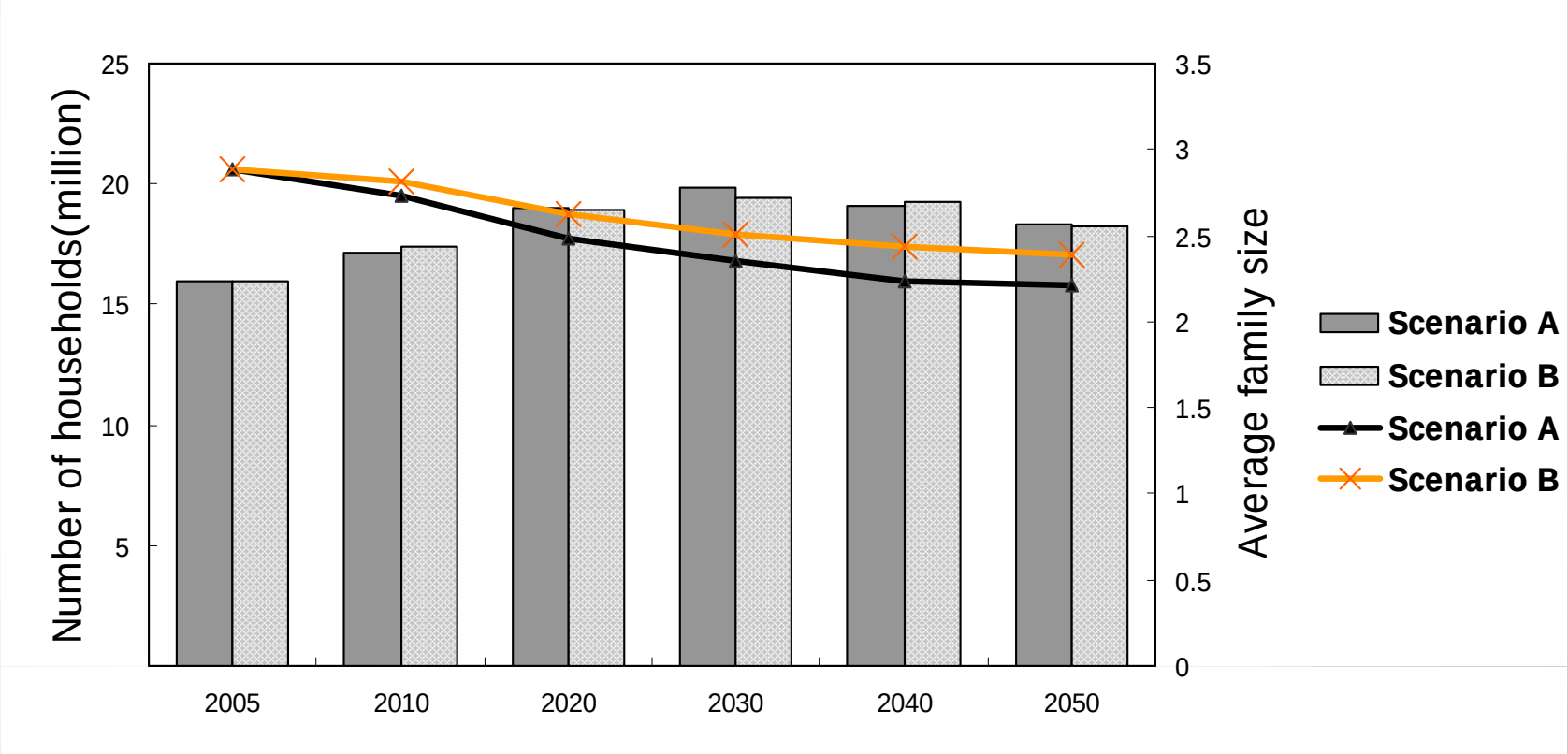
Source : GDP growth rate is based on the potential GDP growth rate form Korea Energy Economics Institute (KEEI) and internal document of Korea Environment Institute (KEI)

Projection of Population



Scenario A : projection from Korea National Statistical Office's (KNOS) prospect data is used.
Scenario B : It is assumed that scenario B will have higher birth rate than scenario A.

Household and average family members

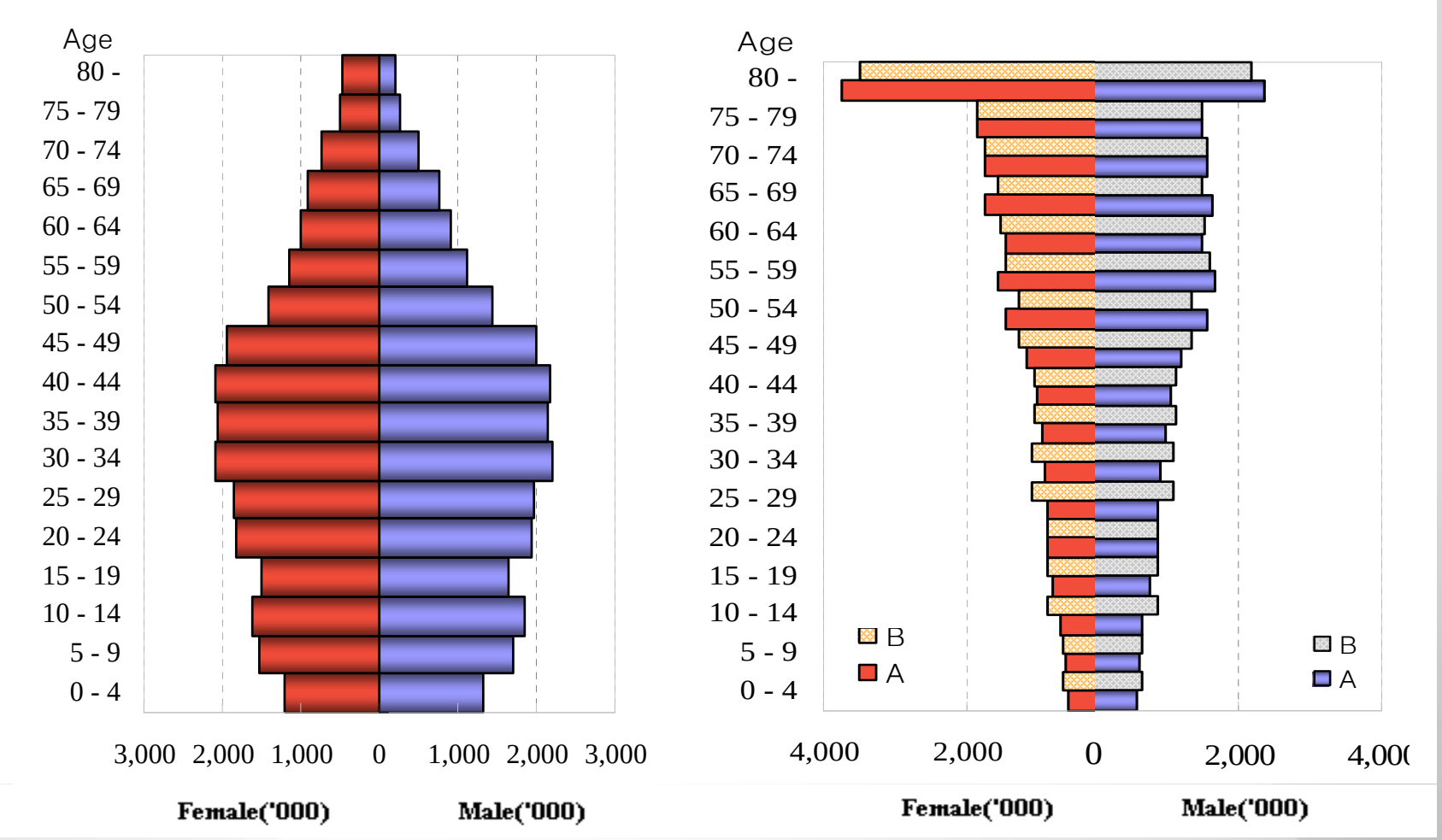


Scenario A : data from Korea National Statistical Office's (KNSO) is used for 2005~2030 and the projection from 2031 to 2050 is estimated.

Scenario B : Small increase of birth rate compare to that of Scenario A and number of average household members decreases than that of Scenario A.

Population structure by age

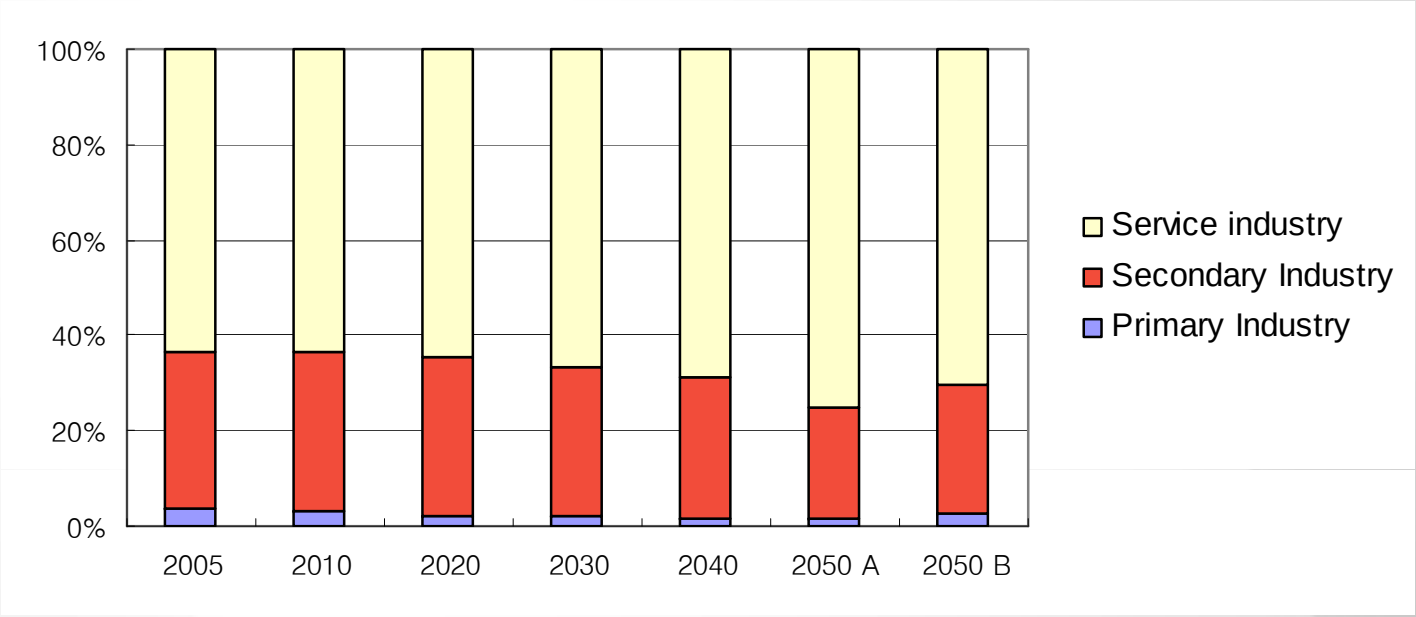
- In 2050 korea become ageing society



Scenario A : projection from Korea National Statistical Office's (KNOS) prospect data is used.
Scenario B : It is assumed that scenario B will have higher birth rate than scenario A.

Industrial structure

- Increase in GDP share due to growth of IT and finance sector
- Scenario B has a large share of agricultural sector than that of scenario A due to less urbanization
- Service industry will grow up continuously



Data from 2005 to 2030 are from KIET. From 2031 to 2050, the share of each industry is estimated by each scenario

Industrial structure

Major premises

- The major manufacturing industry - Information & Communication Technology (ICT), automobile, and ship-building – are expected to lead the economic growth by advancing the industries.

- Agriculture, forestry, and fisheries: higher demands on organic product will raise the value of primary industry (Scenario B).

- Publication and Printing industry: Expansion of computer and informatization tools will reduce the importance of publishing business.

- Education and Research: Transition to knowledge-based society and lifelong education system will further develop education industry.

- Real estate: Decline of number of households and decentralization will reduce the momentum.

- Transportation: Full adoption of five-day workweek and development of entertainment business will increase the potential transportation demand.

Modeling Approach

- Energy snap shot tools is used to calculate energy consumption of end use sector
- To calculate modal share in transportation sector AIM Enduse model is used
- The volume of service on each energy use type is calculated through national projection data and trend analysis based on previous data
- Total amount of electric energy demand is compare with internal MOICE (Ministry of Commerce, Industry, Energy) power generation plan

Residential sector

Basic assumptions

	2005	2050 A (increasing rate)	2050 B (increasing rate)
Households('000)	15,971	18,330 (14.7)	18,252 (14.3)
Average floor area/ person	20.2	40 (51.4)	36 (47.4)

(1) Number of households

- The estimated number of households using the data of 2030 provided by the Korea National Statistical Office is followed
- Scenario B has a greater individual household share than that of Scenario A.

(2) Average floor area

- Increased ratio of floor area is calculated through multiplying average per capita floor area by average number of household members.
- The figure in 2050 is estimated based on the data for the average floor area of 2020 which was projected by Korea Research Institute for Human Settlements (KRIHS)

Residential sector

Service volume and Energy share

- The conservation ratio is equal to CM/REF level backed by diverse policies, energy-saving products, insulation, and changes in living patterns

	Unit	2005	2050					
			REF		CM		CM/REF	
			A	B	A	B	A	B
Space cooling	Mtoe	1.6	5.8	4.2	5.0	3.3	85%	80%
Hot water and heating	Mtoe	10.1	16.6	13.6	14.9	12.2	90%	90%
Cooking	Mtoe	1.6	1.9	1.9	1.9	1.9	100%	100%
Lighting	Mtoe	1.0	1.7	1.4	1.6	1.2	90%	85%
Refrigerators	Mtoe	0.5	1.0	0.7	1.0	0.7	100%	100%
ICT appliance	Mtoe	0.7	2.7	1.7	2.5	1.5	95%	90%
Cloth washers	Mtoe	0.2	0.2	0.2	0.2	0.2	100%	100%
Other Appliance	Mtoe	1.1	3.8	2.1	3.4	1.8	90%	85%

- In case of hot water and heating service, oil-boilers will be replaced by others such as solar thermal energy generators, electric-boilers and gas-boilers due to high oil prices.
- Scenario B has more environmentally-friendly energy share than Scenario A.
- In case of cooking, electricity will have a bigger share.

Commercial sector

Basic assumptions

- The increasing rate of 2050 is computed through the analysis of variations of building area, reflecting the basis year data from the National Statistics Office.
- Each energy service demand is calculated after estimating energy share in 2050 reflecting the variations in building floor area and demand for the total energy.

Energy consumption per floor area for energy service (100 in 2005)

	2005	2050 A	2050 B
Hot water and heating	100	151.35	133.84
Cooling	100	158.16	139.27
Cooking	100	130.65	117.34
Other Appliance	100	153.23	135.34
Motor etc.	100	152.65	134.87
Lighting	100	150.19	132.91

Commercial sector

Service volume and Energy share

	Unit	2005								
		COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total
hot water and heating	-	0%	28%	28%	1%	0%	2%	0%	41%	100%
Space cooling	-	0%	1%	10%	0%	0%	0%	0%	89%	100%
cooking	-	0%	2%	78%	5%	0%	0%	0%	15%	100%
Facilities	-	0%	2%	1%	0%	0%	0%	0%	97%	100%
Self-Generation	-	0%	43%	57%	0%	0%	0%	0%	0%	100%
Lighting	-	0%	0%	0%	0%	0%	0%	0%	100%	100%
	-	0%	0%	0%	0%	0%	0%	0%	0%	0%
	-	0%	0%	0%	0%	0%	0%	0%	0%	0%
	-	0%	0%	0%	0%	0%	0%	0%	0%	0%
	-	0%	0%	0%	0%	0%	0%	0%	0%	0%
	-	0%	0%	0%	0%	0%	0%	0%	0%	0%

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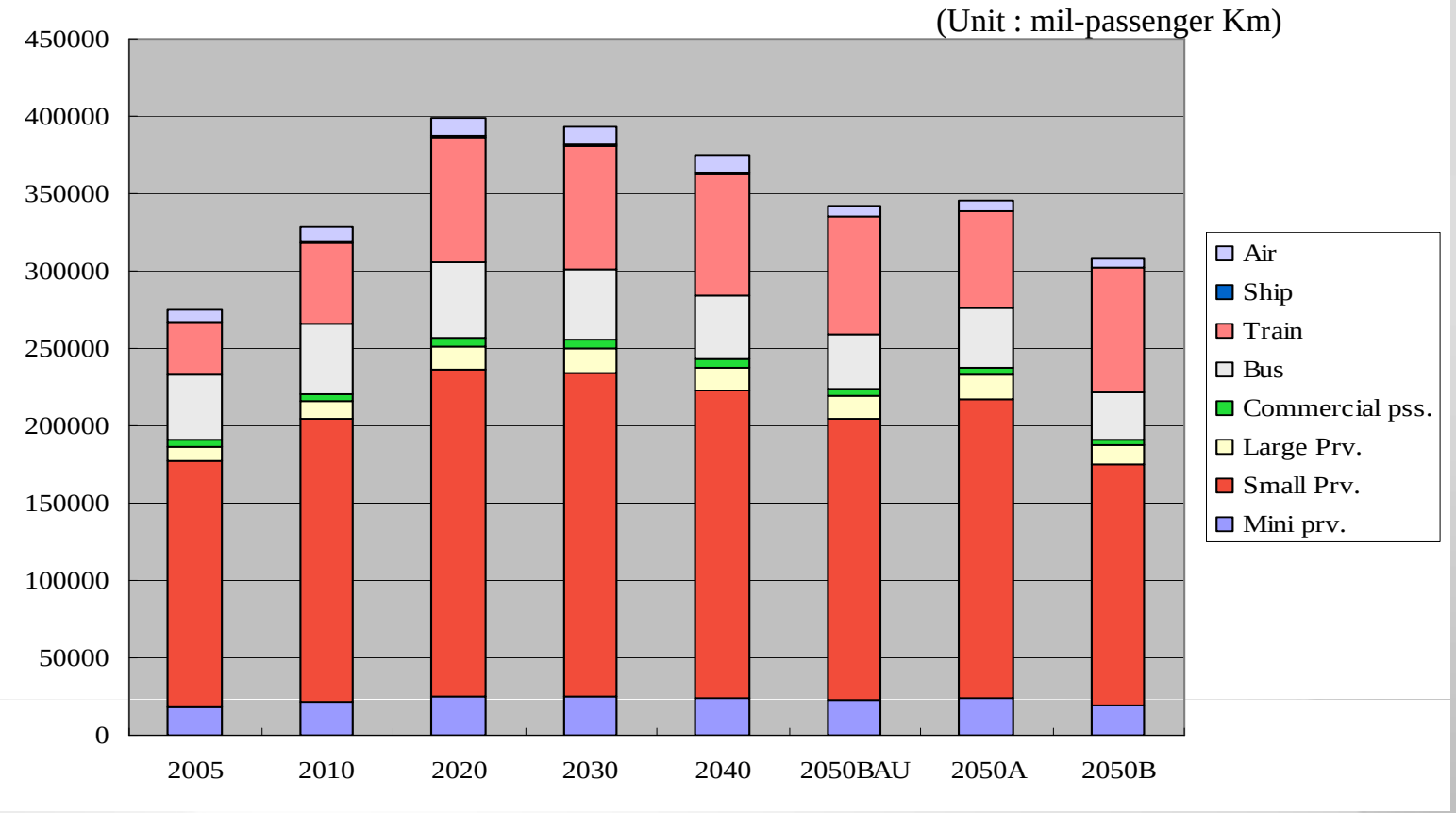
	2050A						2050B					
	OIL	GAS	BMS	S/W	Heat	ELE	OIL	GAS	BMS	S/W	Heat	ELE
hot water and heating	5	30	-	5	15	45	10	15	10	20	-	45
Space cooling	-	-	-	-	-	100	-	-	-	-	-	100
cooking	-	65	-	-	-	35	-	50	20	-	-	30
Facilities	-	-	-	-	-	100	-	-	-	-	-	100
Self-Generation	20	80	-	-	-	-	20	80	-	-	-	-
Lighting	-	-	-	-	-	100	-	-	-	-	-	100

Passenger transportation Sector

Service volume

- Scenario B reflects a reduction of 10% in the total passenger demand compared to Scenario A, taking into consideration the bike-related policy announced by Ministry of Government Administration and Home Affairs



Domestic demand alone is taken into account in estimating demand for shipping by air or sea

Passenger transportation Sector

Service share and Energy efficiency

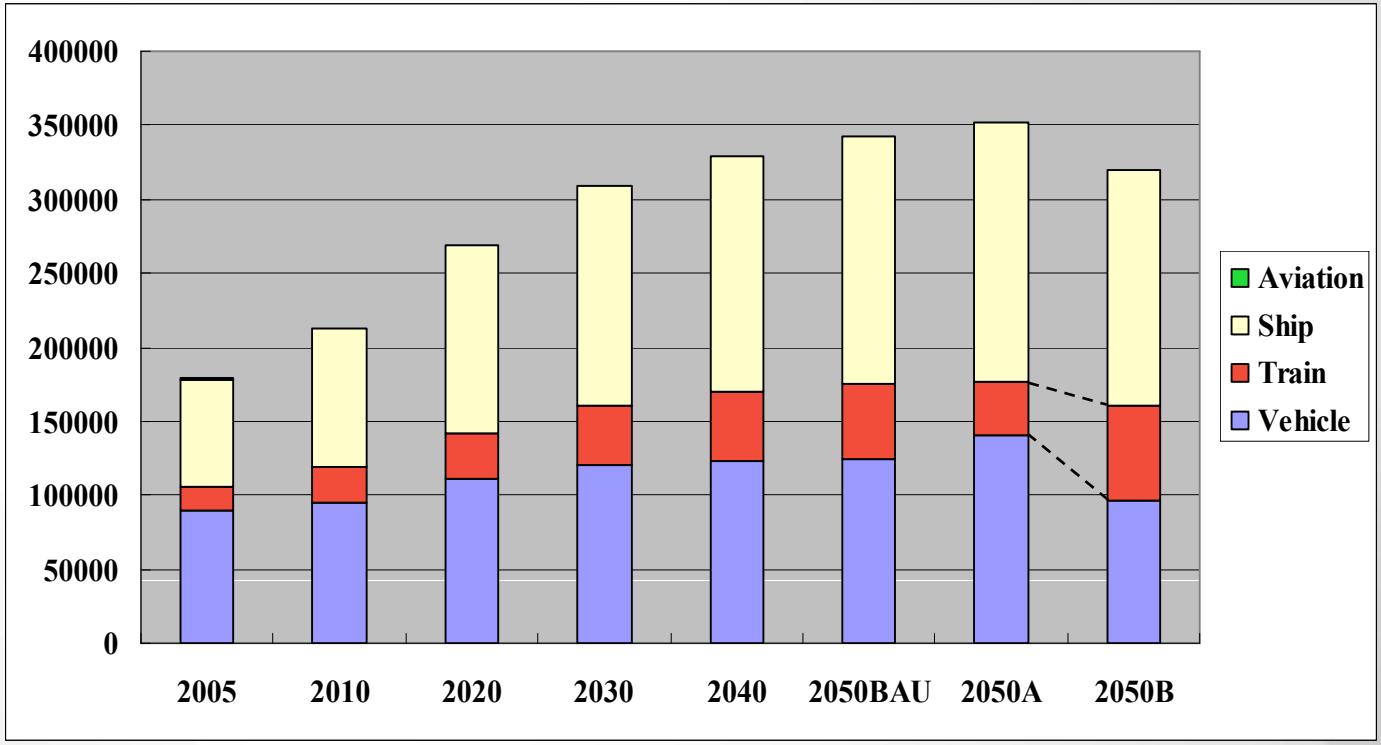
	Unit	2005								
		COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total
Mini prv.	-	0%	73%	25%	2%	0%	0%	0%	0%	100%
Small Prv.	-	0%	65%	35%	0%	0%	0%	0%	0%	100%
Large Prv.	-	0%	65%	35%	0%	0%	0%	0%	0%	100%
Commercial pss.	-	0%	65%	35%	0%	0%	0%	0%	0%	100%
Bus	-	0%	99%	1%	0%	0%	0%	0%	0%	100%
Train	-	0%	14%	0%	0%	0%	0%	0%	86%	100%
Ship	-	0%	100%	0%	0%	0%	0%	0%	0%	100%
Air	-	0%	100%	0%	0%	0%	0%	0%	0%	100%
	-	0%	0%	0%	0%	0%	0%	0%	0%	0%
	-	0%	0%	0%	0%	0%	0%	0%	0%	0%
	-	0%	0%	0%	0%	0%	0%	0%	0%	0%

- The average fuel efficiency of the internal-combustion engines of cars will be triple that of 2005 and the average COP of internal-combustion engines powered by hydrogen fuel cells and electricity will be boosted from 3.0 to 4.0 and from 3.0 to 5.0 respectively.
- The fuel efficiency of trains will be double that of 2005.
- The fuel efficiency of ships will be 1.33 times higher than that of 2005.
- Airplanes will have a 1.5 times higher energy efficiency than that of 2005 on average

Freight transportation sector

Service volume

(Unit : mil-ton Km)



Domestic demand alone is taken into account in estimating demand for shipping by air or sea

Freight transportation sector

Service share and Energy efficiency

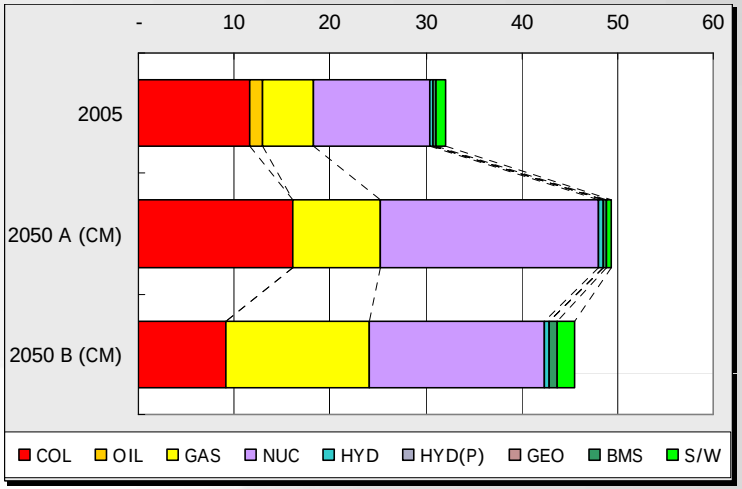
	Unit	2005								
		COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total
Small Freight (≤1ton)	-	0%	73%	27%	0%	0%	0%	0%	0%	100%
Large Freight (>1ton)	-	0%	93%	7%	0%	0%	0%	0%	0%	100%
Train	-	0%	85%	0%	0%	0%	0%	0%	15%	100%
Ship	-	0%	100%	0%	0%	0%	0%	0%	0%	100%
Air	-	0%	100%	0%	0%	0%	0%	0%	0%	100%

- The average fuel efficiency of the internal-combustion engines of small freight cars will be three times higher than it was in 2005 while the average COP of internal-combustion engines operated by hydrogen fuel cell and electricity will increase from 3.0 to 4.0 and from 3.0 to 5.0 respectively.
- The average fuel efficiency of the internal-combustion engines of mid-sized freight cars will be 1.52 times higher than it was in 2005 while the average COP of internal-combustion engines operated by electricity will rise five times between 2005 and 2050.
- The fuel efficiency of trains will be double that of 2005.
- The fuel efficiency of ships will increase by 1.33 times between 2005 and 2050.
- The average fuel efficiency of airplanes will improve by 1.5 times during the same period.

Power generation sector

Energy mix

(Unit : Mtoe)	2005		2050A		2050B	
Coal	11.61	35.9%	16.20	32.8%	9.11	20.0%
Oil	1.38	4.3%	0.00	0%	0.00	0%
Gas	5.25	16.2%	9.12	18.5%	15.05	33.0%
Nuclear	12.64	39.1%	22.59	46.0%	18.22	40.0%
Hydro	0.43	1.3%	0.44	0.9%	0.44	1.0%
Renewable	0.09	0.3%	0.99	2.0%	2.73	6.0%
Total	32.30	100%	49.34	100%	45.56	100%

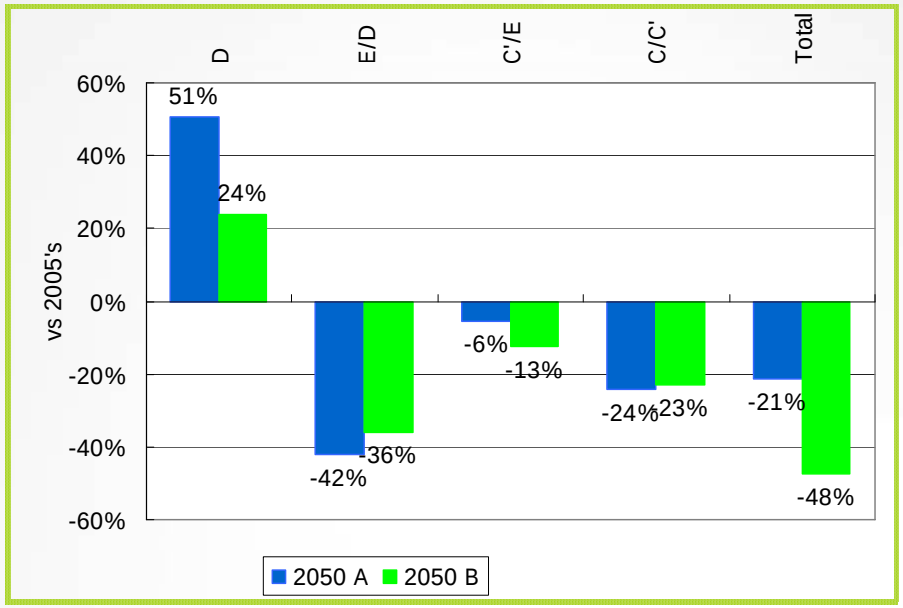


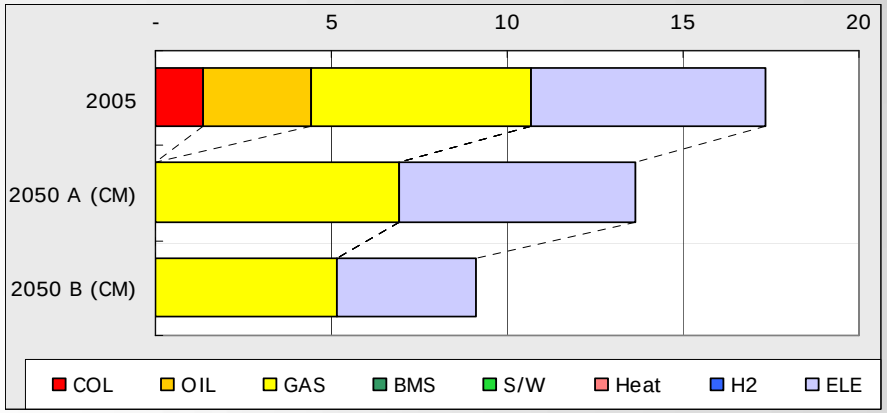
Power generations by fuel types (Mtoe)

- Each scenario estimates the amount of power generated by each energy source in 2050 based on the Power Sector Plan (2005 – 2020) of MOCIE(Ministry of Commerce, Industry and Energy)
- Midnight electric power or wind power is utilized to meet demand for hydrogen-based energy in the transportation sector
- The CO_2 emitted from coal and gas thermal power generation and the CO_2 emitted during natural gas reforming for the purpose of hydrogen production is subjected to carbon capture and storage

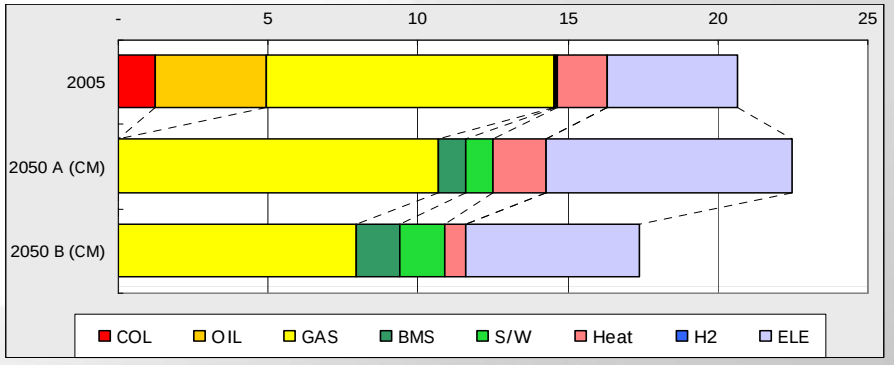
Result

Residential sector





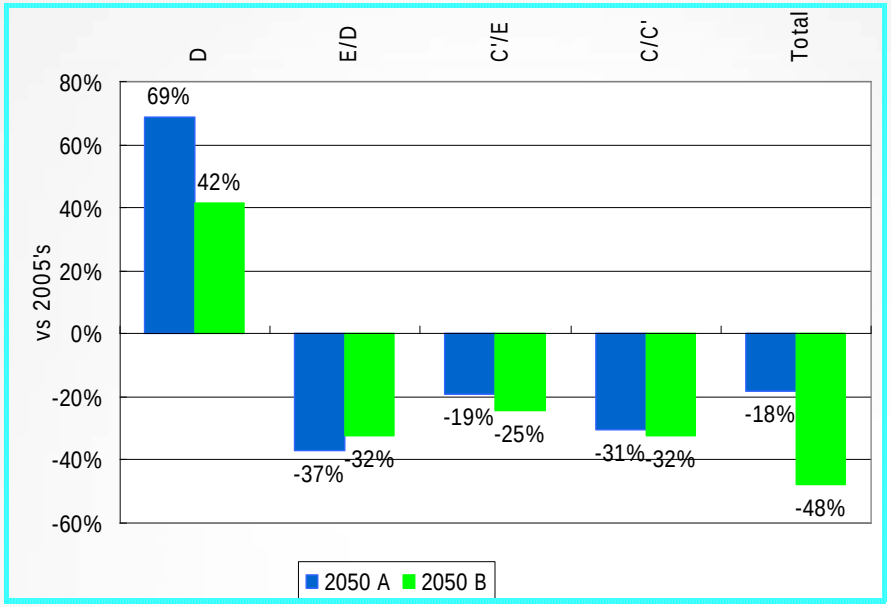
CO_2 emission in residential sector with allocated emission from heat, H2, electricity (MtC)

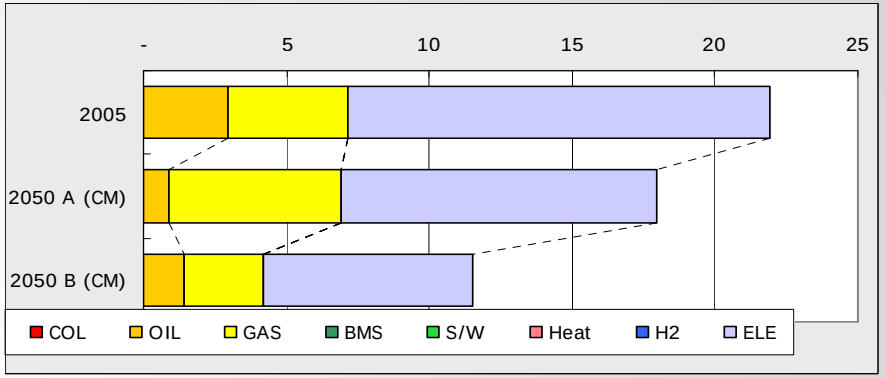


Energy consumption in residential sector (Mtoe)

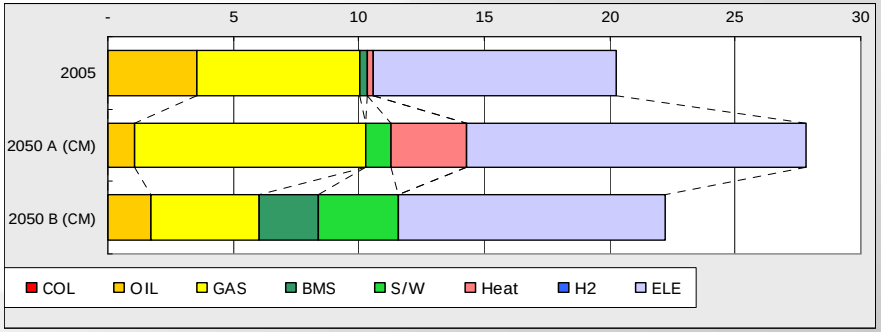
- **Total CO_2 emission reduction**
  - Scenario A : 21% from base year
  - Scenario B : 48% from base year

Commercial sector





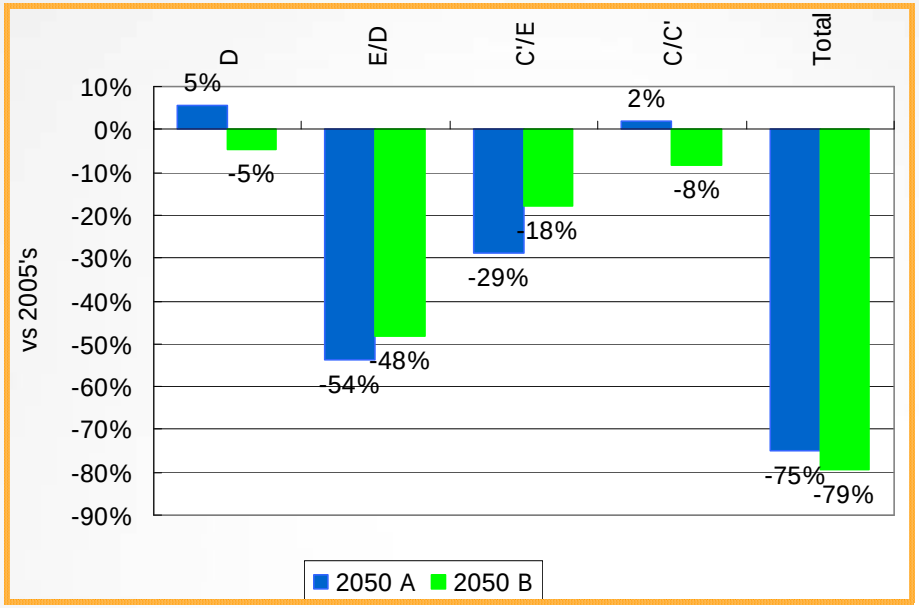
CO_2 emission in commercial sector with allocated emission from heat, H2, electricity (MtC)



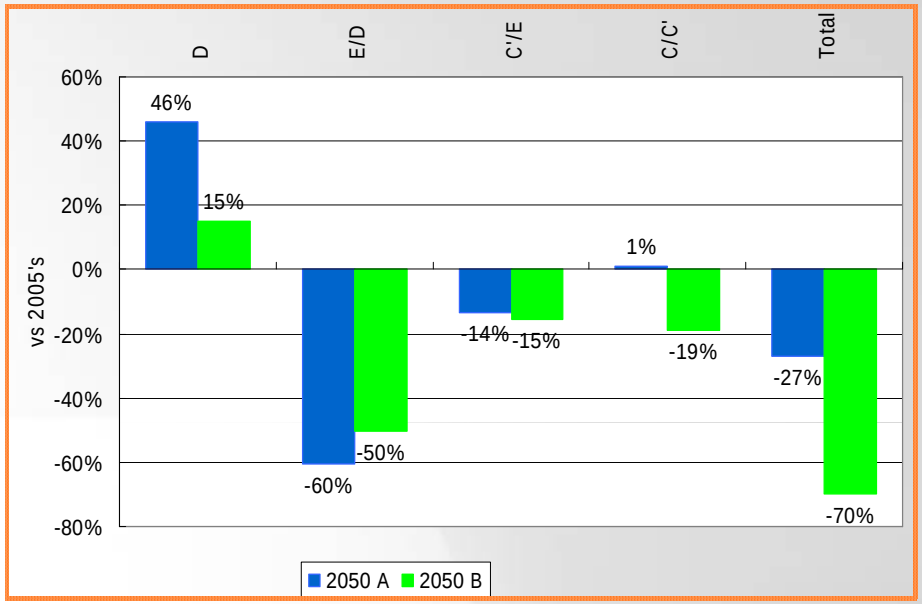
Energy consumption in commercial sector (Mtoe)

- **Total CO_2 emission reduction**
  - Scenario A : 18% from base year
  - Scenario B : 48% from base year

Transportation sector



(Passenger)



(Freight)

- **Total CO_2 emission reduction**

- Scenario A : 75% from base year
- Scenario B : 79% from base year

- Scenario A : 27% from base year
- Scenario B : 70% from base year

All sectors

Factor analysis

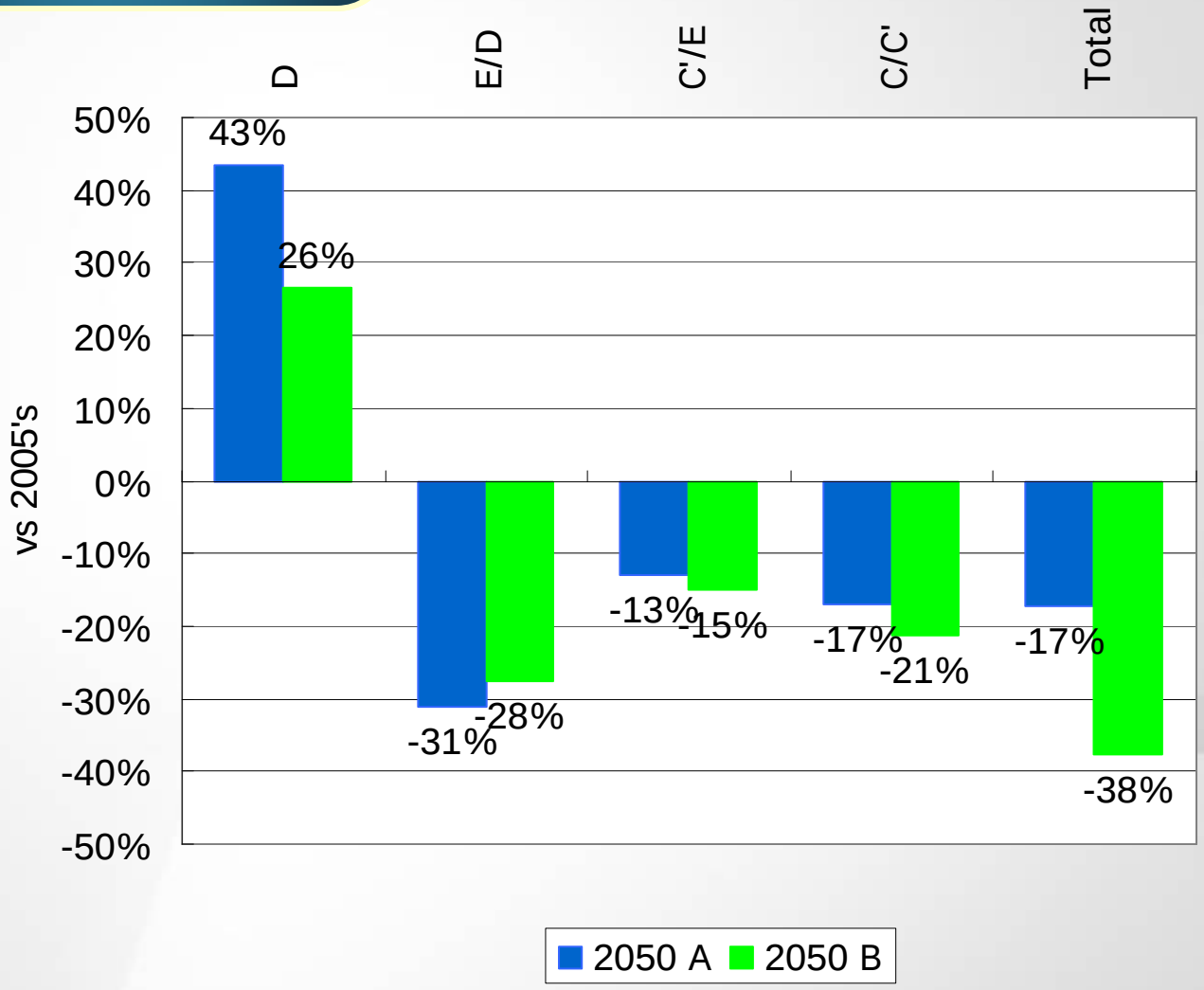
		2050 A						2050 B					
		IND	RES	COM	TR-P	TR-F	Total	IND	RES	COM	TR-P	TR-F	Total
Change rate	D	38%	51%	69%	5%	46%	43%	31%	24%	42%	-5%	15%	26%
2050/2005	E/D	-12%	-42%	-37%	-54%	-60%	-31%	-13%	-36%	-32%	-48%	-50%	-28%
	C'/E	-9%	-6%	-19%	-29%	-14%	-13%	-11%	-13%	-25%	-18%	-15%	-15%
	C/C'	-19%	-24%	-31%	2%	1%	-17%	-20%	-23%	-32%	-8%	-19%	-21%
	Total	-2%	-21%	-18%	-75%	-27%	-17%	-14%	-48%	-48%	-79%	-70%	-38%
CO2 share	2005	46%	14%	17%	9%	14%	100%	46%	14%	17%	9%	14%	100%

- The CO_2 emissions in 2050 will be reduced by 17% in Scenario A, and 38% in Scenario B respectively as compared to 2005.

- It is worthwhile to note that approximately 8% of CO_2 emissions will captured by CCS.

All sectors

Factor analysis



Policy Issues

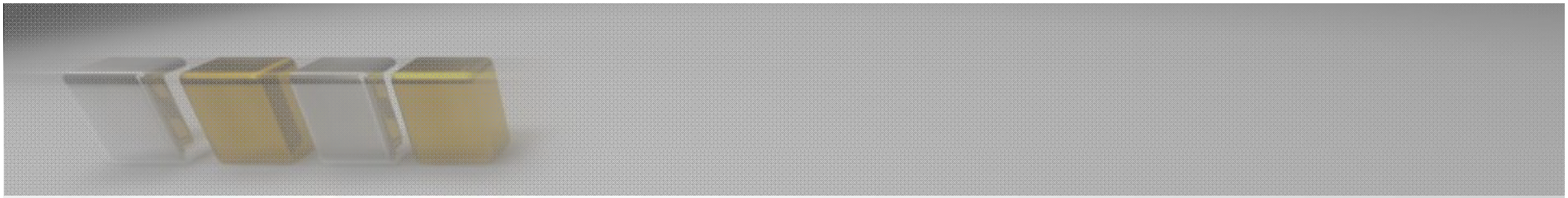
- **Extend the use of low carbon energy**
- **Increase investment of renewable energy (solar, wind, etc)**
- **Introduce a partial reduction duty using Renewable Portfolio Agreement (RPA)**
- **In industrial sector, strengthen of voluntary agreement (Voluntary Agreement → Negotiated Agreement)**
- **Advancing a whole nation energy frugality campaign with citizen group**

Conclusion and remarks

- 17~38% CO_2 reduction will be achieved than that of 2005 when improvement of technology, change of energy mix and reduction of CO_2 emission using CCS are realized
- It is difficult to setting up the CO_2 emission reduction target than that of 1990 because of korea socio-economic states (3.8% GDP annul growth, Increasing population and household)
- Current korea's technological level related CO_2 reduction is 60~75% than that of advanced country. Intensive investment in te chnology is needed to achieve Low Carbon Society
- In transportation sector, korea government plan to intensive investment to construct hydrogen station to change automobile standard with 4 stage construction plan

Further work

- Data Supplement to match up new economical policy and adjust bottom up approach
- Design of policy roadmaps toward the Low Carbon Society
- Feasibility analysis of the roadmaps considering the policy
- Application of ESS model to local area to check up possibility



Thanks for your attention